B-1185
[1-4]

Indian J. Anim. Res.,
Print ISSN:0367-6722 / Online ISSN:0976-0555

AGRICULTURAL RESEARCH COMMUNICATION CENTRE
www.arccjournals.com

Estimation of Population Parameters and Stock Assessment of *Mastacembelus armatus* in the Taojiang River, Xinfeng County, Jiangxi Province, China

Wu Bin[1], Wang Haihua*[1], Ma Benhe[1], Xu Xiandong[1] and Zeng Qingxiang[2]

Fisheries Research Institute of Jiangxi Province, Scientific Observing and Experimental Station of Fishery Resources and Environment in Poyang Lake, Ministry of Agriculture, 330000 Nanchang, China.

Received: 30-07-2019 Accepted: 06-11-2019 DOI: 10.18805/ijar.B-1185

ABSTRACT

A study was conducted to investigate the growth parameters, mortality and recruitment pattern of *Mastacembelus armatus* collected in the Taojiang River fish landing site, Xinfeng County. *M. armatus* were collected from March, 2018 to February, 2019. Growth parameters, asymptotic length (L_∞) = 58.8cm and growth coefficient (*k*) = 0.13 year^{-1}. Growth performance index(Ø′) =2.65, total mortality (Z) = 0.75 year^{-1}, natural mortality (M) = 0.32 year^{-1}, fishing mortality (F) = 0.43 year^{-1} and exploitation rate (E) = 0.57 year^{-1}. The estimated exploitation rate (E) has slightly exceeded the optimum value of E indicating this species was over exploited mainly due to fishing in the study area. The exploitation ratios were computed as E_{max} = 0.59, E_{10}= 0.45, E_{50}= 0.31. The length at first capture at 50%, (L_c) was 19.51 cm. The Steady biomass also increased with length class until 36.0-36.9 cm and the total steady state biomass was found to be 19.12 tons.

Key words: Growth, *Mastacembelus armatus*, Mortality, Population parameters, Xinfeng county.

INTRODUCTION

Mastacembelus armatus has a long body, small head, protruding lips and 33-34 spines on the dorsal fin,so called “knife loach” (Huang, 1999). This species has been investigated for farming in recent years and studies have been carried out on genetic diversity, chromosomes karyotype, artificial induced spawning, feeding habit, Reproductive biology and fish community (Li, 2019; Zhou, 2019; He, 2019; Zhan, 2018; Zeng, 2016; Huang, 1999). It is surprising how little we know about the population parameters and stock of *M.armatus*. The objectives of this study was to assess four important parameters namely growth, natural and fishing mortality and recruitment of *M.armatus* in the Taojiang River, Xinfeng County. The Taojiang River belongs to the second tributary of Ganjiang River, originating from the highest peak in Quannan County. The main peak of the mountain is Yanchizhang, 1145 meters above sea level. The Taojiang River passes through 85.3km in Xinfeng County, goes up to Longnan County and goes to Zhanggong District.

MATERIALS AND METHODS

The study was carried out in the Taojiang River, west part of Xinfeng County (Latitude: 25°17'29"N, Longitude: 114° 92' 94"E), from March, 2018 to February, 2019. Monthly random samples of *M.armatus* were caught using cage net and the length of the fishing area was about 1 kilometers (Fig 1). The annual average temperature was 18.5°C. The body length (BL, from the tip of the snout to the end of the caudal fin) was measured along the dorsal mid-line to the nearest 1 mm. A total of 255 *M.armatus* were used in this study. The length frequency data of *M.armatus* were analyzed using the FiSAT II program (FAO-ICLARM Stock Assessment Tools-Version 1.2.2). The FiSAT routines were followed thoroughly, based on the user’s manual (Gayanilo, 2005) and reference manual (Gayanilo, 1997). Bhattacharya’s method (BM), implemented from the package FiSAT II (Gayanilo,1996), was used to simulate the Von Bertalanffy equation: $L_t = L^* [1-\exp(-k^*(t - t_0))]$ to calculate the asymptotic length $L\infty$ and the growth parameter *k*, where, L_t is the length at age t, $L\infty$ is asymptotic length (computed as L_{max} /0.95, where L_{max} is the maximum recorded length), *k* is the curvature parameter and t_0 is the initial condition parameter (Bertalanffy, 1938). Given a distribution in size classes, Bhattacharya’s (1967) method allows for the iterative computation of regression lines up to the total decomposition of the overall size-frequency distribution.

RESULTS AND DISCUSSION

The length frequency data of *Mastacembelus armatus* was analyzed in FiSAT software using various methods to estimate the growth, mortality and recruitment. For commercially utilized fish species, growth parameters ($L\infty$ and *k*) have been estimated because these population parameters are important to describe the species and input data in several fishery production models (Hilborn, 1992). $L\infty$ is the largest theoretical mean length that a species could attain in its habitat whereas k is related to the speed it grows towards their final size.

*Corresponding author’s e-mail: haihuawang998@sina.com
[1]Fisheries Research Institute of Jiangxi Province, Scientific Observing and Experimental Station of Fishery Resources and Environment in Poyang Lake, Ministry of Agriculture, 330000 Nanchang, China.
[2]Fisheries Research Institute of Ganzhou, 341000 Ganzhou, China.

Fig 1: Location of study and landing areas for *Mastacembelus armatus.*

Bhattacharya's plot: By using the Bhattacharya's method in FiSAT, *M.armatus*, one group or cohort at modal length 23.83 ±3.67 cm was obtained (Fig 2).

Growth parameters: A total of 255 *M.armatus* were examined and their length-mass relationships were computed as body mass = 0.004× body length$^{2.85}$(R^2=0.90;p<0.05). Length-mass relationship indicated isometric growth with b= 2.85. The parameters of the Von Bertalanffy growth equation (VBGF) L∞ and *k* were estimated by running the program Shepherd's method included in the FiSAT package. The monthly length-frequency distributions fitted with growth curves, are presented in Fig 3. This routine gave the L∞ = 58.8 cm and *k* = 0.13 year^{-1} (Table 1).

This value was found to be the best combination of L∞ and *k* with the score being 1.0 (Fig 4). This value was further used to obtain the graph of von Bertalanffy Growth Function (VBGF). The VBGF of *Mastacembelus armatus* illustrated in Fig 3 indicated that the origin of the growth curve starts in Middle and late April for the group of *M.armatus*. On annual basis, the growth of *M.armatus* was described by the following Von Bertalanffy growth equations: $L= 58.8 (1 - e^{-013(t+1.83)})$;$W = 436.0 (1 - e^{-013(t+1.83)})^{2.85}$.Pauly and Munro (1984) have indicated a method to compare the growth performance of various fish stock by computing a growth performance index (Ø′) = log *k* + 2log L∞. Generally, the growth performance index (Ø′) is a species specific parameters, which means that their values are usually similar within related taxa and have narrow normal distributions. The growth performance index for *M.armatus* was 2.65.

Mortality coefficients: The Z, M and F of *M.armatus* were estimated as 0.75 year^{-1}, 0.32 year^{-1} and 0.43 year^{-1} (Table 1), respectively, illustrated in Fig 5. *M.armatus* in the Taojiang River, showed low mortality rates which relates to fishing mortality and natural mortality. The exploitation rate was estimated to be 0.57 year^{-1}.

Length at first capture (Lc): The length at first capture, Lc of *M.armatus* was estimated at 19.51 cm (Fig 6). The L_c was the length at which 50% of the fish are vulnerable to be captured by fishermen. This is the average size of fish vulnerable to fishing or enter the fishing ground, in the Taojiang River (Table 1).

Recruitment pattern: The recruitment patterns of *M.armatus* suggested that there was one main pulse of annual recruitment, in agreement with the group separation using Bhattacharya's Plot. The major pulse appeared in the end of May, or the beginning of June (Fig 7).

Relative yield-per recruit (Y′ /R) and relative biomass-per recruit (B′ /R): The exploitation ratios were computed as E_{max} = 0.59, E_{10} = 0.45, E_{50} = 0.31(Fig 8). Here, E_{max} is the exploitation rate at which, maximum sustainable yield per recruit is obtained, E_{10} is the exploitation rate which was the marginal increase of relative yield per recruit was 1/10th and E_{50} is the value of E under which the stock had been reduced to 50% of its unexploited biomass.

Virtual population analysis: From virtual population analysis it was found that the maximum fishing mortality of *M.armatus* occurred at the length range between 23 cm and 24 cm indicating low fishing mortality in the juvenile stage

Table 1: The population parameters for *M.armatus* from length data.

L∞ (cm)	*k* (year^{-1})	M (year^{-1})	F(year^{-1})	Z (year^{-1})	E (year^{-1})	L_c(cm)
58.8	0.13	0.32	0.43	0.75	0.57	19.51

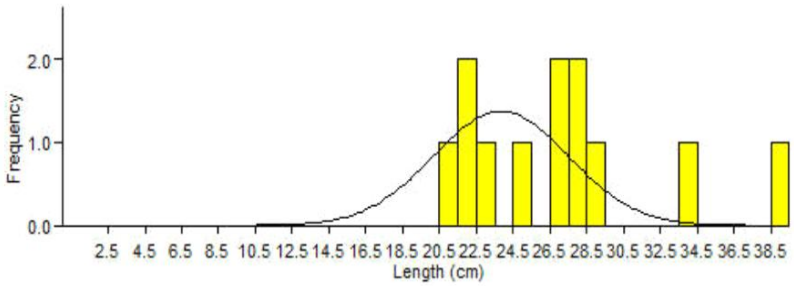

Fig 2: Decomposition of Composite Distributions using Bhattachrya 's Method.

(Fig 9). Steady biomass also increased with length class until 36.0-36.9 cm and the total steady state biomass was found to be 19.12 tons.

The "b" value of *M.armatus* was found 2.85. The "b" value was estimated to be slightly <3 which indicates relatively lesser body mass in relation to increment in body length (Kannan, 2016). Estimate of L∞ are similar whereas the k in current studies is substantially higher than their estimate. Sparre and Venema (1992) stated that the value of k = 1.0 is fast growth, k = 0.5 is medium growth and k= 0.2 is slow growth. Hence, k=0.13, for *M.armatus* obtained from this study is considered as slow growth (Wu, 2018). Mortality means the death of fish from the stock due to fishing mortality or natural mortality including predation, disease and old age. Fishing mortality assumed to be associated with physical injury or physiological stress from being captured in the gear used during capture. Natural mortality (M) and fishing mortality (F) were additive instantaneous rates that sum up to total mortality (Z). The total mortality coefficient, Z= M + F (Gulland, 1971). When comparing mortality rates to the total births or recruits to the population, we can determine if a population is increasing or decreasing. *M.armatus* from

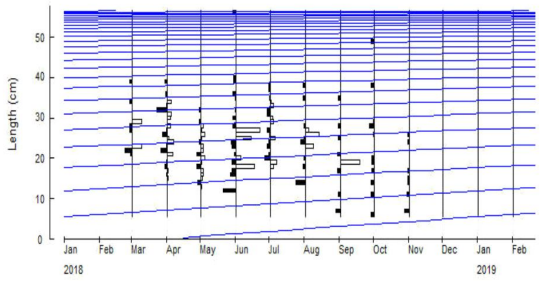

Fig 3: VBGF and Length Frequency Plot.

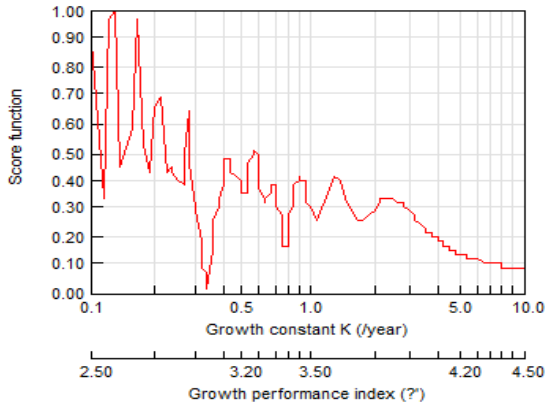

Fig 4: Non-parametric Scoring of VBGF Fit Using Shepherd's method.

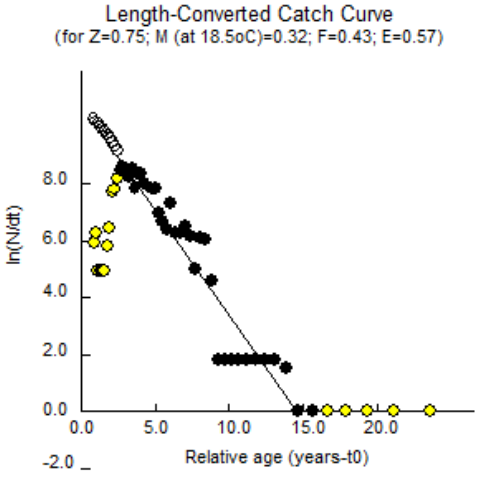

Fig 5: Length-Converted Catch Curve.

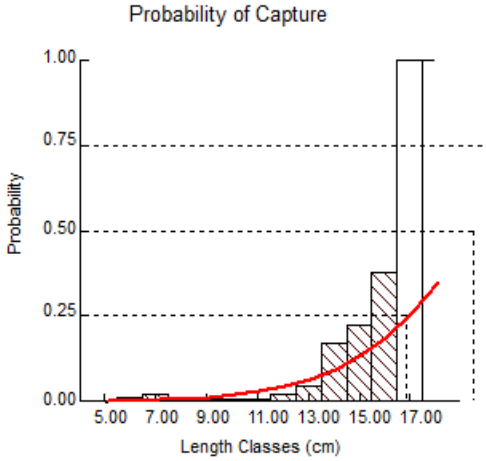

Fig 6: Probability of Capture.

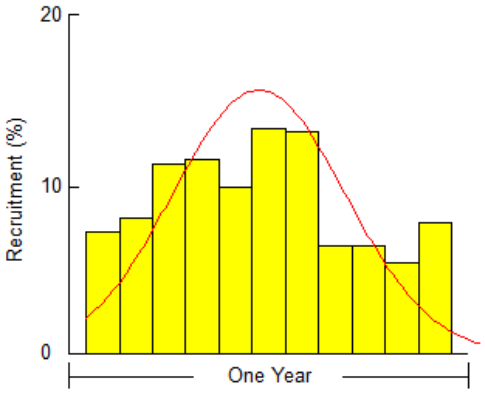

Fig 7: Recruitment Pattern.

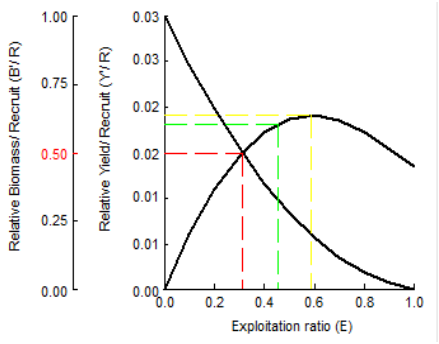

Fig 8: Relative Y′ /R and B′ /R (Knife-edge Selection).

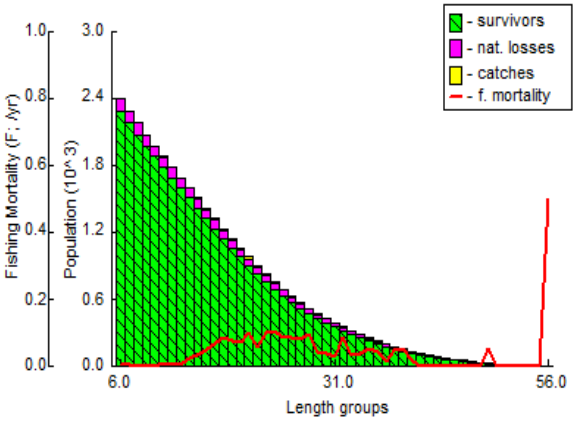

Fig 9: Virtual population analysis.

study area had low total mortality 0.75 year^{-1} and fishing mortality 0.43 year^{-1}. Gulland suggested that the optimum "E" should be 0.5, the exploitation rates 0.57 year-1 indicated this species was over exploited mainly due to fishing in the study area. $E_{present}$ approximately equal E10 and $E_{present}$ > E50, indicating that, at the current rate of exploitation, there is the threat of over fishing as >50% of biomass-per recruit is fished and fishing intensity is appropriate for the economy. The maximum fishing mortality of *M.armatus* occurred at the length range between 23 cm and 24 cm and the total steady state biomass was found to be 24.12 tons. The present study on this species is a preliminary study as it includes only one year of data. However, since no work about the population dynamics on this species has been done. This preliminary work covering growth, natural and fishing mortality and population parameters would help us understand the present status of species. Thus, all of this information would be the valuable sources for comparison in future, especially when the conservation and management of this fish stock is to be made (Hacer, 2018). The estimated exploitation rate (E) has slightly exceeded the optimum value of E indicating this species was over exploited mainly due to fishing in the study area. The stock has been over exploited mainly due to fishing. Considering recruitment and economic interest, it was suggested that capture intensity should be controlled in a timely manner to prevent the risk of resource collapse of *M.armatusin* in the Taojiang River and its adjacent waters.

REFERENCES

Bertalanffy, L. von (1938). A quantitative theory of organic growth (Inquiries on growth laws. 2. *Hum. Biol*. **10:** 181-213.

Bhattacharya, C.G. (1967). A simple method of resolution of a distribution into Gaussian components. *Biometrics*. **23:** 115-135. doi: 10.2307/2528285.

Gulland, J.A. (1971). The fish resources of the Ocean. West Byfleet, Surrey, Fishing News (Books), Ltd., for FAO: 1-255.

Gayanilo, F.C. Jr., Sparre, P. and Pauly, D. (1996). FAO-ICLARM stock assessment tools (FiSAT). User's guide. FAO Computerized Information Series (Fisheries). No. 8, Rome, FAO. 126 p.

Gayanilo, F.C. Jr. and Pauly, D. (eds.) (1997). FAO-ICLARM stock assessment tools (FiSAT). Reference manual. FAO Computerized Information Series (Fisheries). No. 8, Rome, FAO. 262 p.

Gayanilo, F.C., Sparre, P. and Pauly, D. (2005). FAO-ICLARM stock assessment tool II (FiSAT II) User's guide. FAO, Rome, 168 pp.

Hilborn, R. and Walters, C. J. (1992). Quantitative FisheriesStock Assessments: Choice, Dynamics and Uncertainty.Chapman and Hall, New York. 570 pp.

Huang Yongchun. (1999). Feeding habit and reproductive biology of Mastacembelue armatus in Tingjiang river. *Journal of Fisheries of China*. Suppl.1-6.

Hacer Yeldan. (2018). Estimating some population parameters and stock assesment of spiny butterfly ray, Gymnura altavela (Linnaeus, 1758) the Levant Basin coast (Northeastern Mediterranean). *Indian J. Anim. Res.* **52**(12): 1790-1796.

He Meifeng,Yuan Dingqing,Cui Lifeng, *et al*. (2019). Study on fish community and impact factors in *Mastacembelus aculedtus* National Aquatic Reserve in Tingjiang River. *Journal of Shanghai Ocean University. China*. **1:** 121-129.

Kannan APS, Rajkumar M, Jawahar P, *et al*. (2016). Stock assessment and reproductive biology of Puntius sarana (Hamilton, 1822) in Tamiraparani River basin of south Tamilnadu, India. *International Journal of Research in Bioloical Sciences*. **6**(2):20-25.

Li Fen, Chen QiPing, He PeiYing, *et al*. (2019). The Karyotype pattern and genetic diversity of mitochondrial DNA Cyt b gene and D-loop sequence in *Mastacembelus aculedtus* Beijiang river, south China. *Oceanologia et Limnologia Sinica. China*. **2:**449-454.

Pauly, D. and Munro, J.L. (1984). Once more on the comparison of growth in fish and invertebrates. *Fishbyte*. **2**(1): 21.

Sparre P, Venema S C. (1992). Introduction to Stock Assessment of Tropical Fish. Beijing: Chinese Agricultural Science and Technology Press, 407.

Wu Bin Wang Haihua Fu Huiyun Zhang Yanping. (2018). Estimating some population parameters and stock assessment of Dark Sleeper *Odontobutis potamophila* in the Gaosha River Wuyuan County, Jiangxi Province. *Indian J. Anim. Res.* **52**(5): 664-668.

Zhan Xue Ling. (2018). Effects of exogenous hormone, temperature and parental weight on artificial induced spawning and incubation of *Mastacembelus aculedtus*. *Acta Hydrobiologica Sinica .China*. **2:**333-340.

Zeng Q X, Fang Y, Zeng X P, *et al*. (2016). The biological characteristics and artificial breeding technology of *Mastacembelue armatus*. *Fisheries of China*. **3:** 70—73.

Zhou Huiqiang, Li Fen, Shu Hu, *et al*. (2019). Analysis on morphological indexes and discrimination of male and female *Mastacembelus armatus*. *Journal of Guangdong Ocean University. China*. **1:** 1-6.